Mill Creek-

Monitoring Stations- SC506, SC519, SC521, SC726 & SC727
USGS Gaging Station- 06888500 (Mill Creek) 12/18/1953-Current
Included area-
HUC 8: 10270102
HUC 10: 03; 04
HUC 12: 01, 02, 03, 04, 05; 01, 02, 03, 04
Streams Flowing to Monitoring Station-

Station	Name	Segment #
SC506	Mill Creek, W Br-	28
West Branch Mill Creek	Mill Creek, W Br-	29
	Loire Creek-	80
SC519	Mill Cr, E Br-	31
South Branch Mill Creek	Mill Cr, S Br-	32
	Mill Cr, E Br-	33
	Unnamed Stream-	693
	Nehring Cr-	81
SC521	Mill Cr-	27
Lower Mill Creek	Hendricks Cr-	73
	Pretty Cr-	74
	Paw Paw Cr-	75
	Spring Cr-	76
	Mulberry Cr-	77
	Dog Cr-	78
	Dry Cr-	79
	Kuenzli Cr-	82
	Snokomo Cr-	85
SC726	Illinois Cr-	30
Illinois Creek		
SC727	Nehring Cr-	81
Nehring Creek		

Monitored Watershed Size- 416.1 square miles
West Branch Mill Creek (SC506) – 107.2 square miles
South Branch Mill Creek (SC519) – 90.2 square miles
Lower Mill Creek (SC521) – 171.5 square miles
Illinois Creek (SC726) – 34.7 square miles
Nehring Creek (SC727) – 12.5 square miles

Land use-

	West Branch Mill Creek	South Branch Mill Creek	Lower Mill Creek	Illinois Creek	Nehring Creek
Permanent Grass	87.98%	90.54%	79.29%	90.85%	93.24%
Cropland	4.35%	2.58%	10.55%	1.91%	0.91%
Forest	4.51%	3.96%	4.73%	5.04%	3.27%
Developed Land	2.87%	2.26%	4.87%	2.02%	2.51%

Counties- Wabaunsee, Morris, Geary & Riley
Cities- Alma, Alta Vista, McFarland, Paxico & Maple Hill
Mill Creek Watershed District- Includes the entire watershed
2000 Population- Overall- 4,453[2]

West Branch Mill Creek (SC506) - 1,090
South Branch Mill Creek (SC519) - 447
Lower Mill Creek (SC521) - 3,320
Illinois Creek (SC726) – 71
Nehring Creek (SC726) - 73

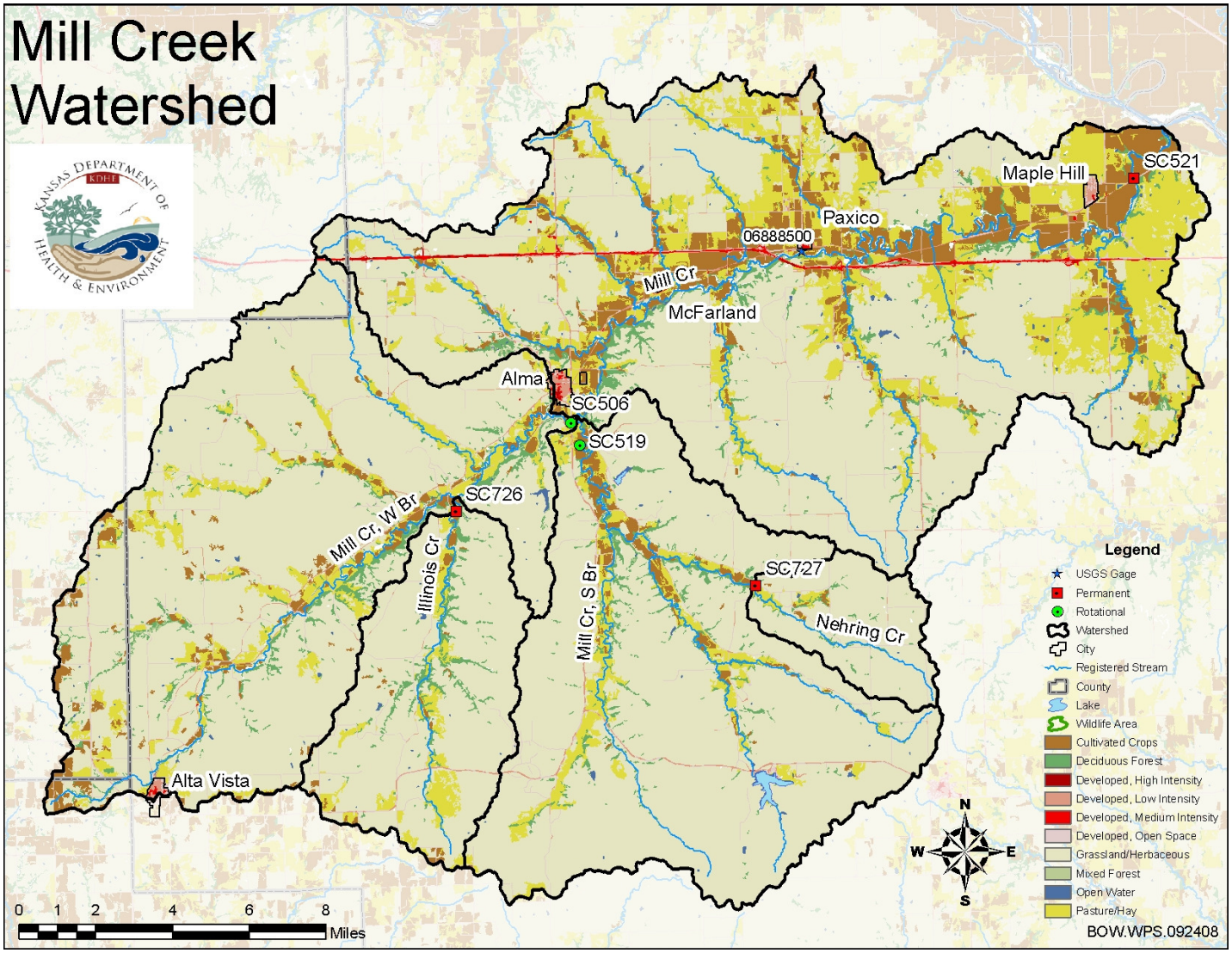
Kansas House Districts – 51, 61, 65, 67, 68
Kansas Senate Districts – 17, 18 & 22

2008 303(d) impaired waters- None
TMDLs- Bacteria, approved 1/26/2000 (SC506, SC519, SC521)
NPDES Permitted Facilities- Alma MWTP (M-KS01-IO01), Maple Hill MWTP (M-KS39-OO01), McFarland MWTP (M-KS41-OO01), Wabaunsee County S.D. #1 (M-KS57-NO01), Paxico MWTP (M-KS57-OO01), KDOT Rest Area (M-KS57-OO02), Lake Wabaunsee Improvement District (M-KS92-OO02), Granma Hoerner's (C-KS01-NO01), Quality Gas & Shop (C-KS01-NO01), Maple Hill Truck Stop (C-KS39-NO01), Wyldewood Cellars Winery (C-KS57-NO01), Stuckey's (C-KS57-NO03), Keith Scott & Co. (Maginley)(I-KS57-PO02), Keith Scott & Co. (Heigert)(I-KS57-PO02)

Permitted Confined Animal Feeding Operations-11

Animal Type	Total Animals
Beef	10,126
Dairy	189
Swine	1115

[2] Individual monitoring station populations add up to greater than the total population due to census boundaries that cross watershed boundaries.



Overview map of the Mill Creek watershed. Land use from the 2001 National Land Cover Dataset.

Stream Chemistry-

The monitoring stations in the Mill Creek watershed have the top four ranked stations in the Middle & Upper Kansas sub-basins, and five of the top six. In other analyses, this watershed has had some of the best overall water quality in the state. The worst individual rank in this area was for TSS at Lower Mill Creek (SC521), with a ranking of 9 out of 19, or better than half of all monitoring stations included in this analysis. The best ranks go to the more upstream areas, suggesting some level of degradation occurring as water moves downstream. Nehring Creek is ranked more poorly than might be expected for TN and E. coli, suggesting that some level of livestock related reduction in water quality may be occurring in that small area of the watershed, relative to the other stations. Overall, the concentrations of pollutants in the Mill Creek watershed fall below levels of concern based on ecoregional guidance, contact recreation criteria, and state water quality standards, with one possible seasonal exception at the most downstream monitoring station.

More downstream stations show increasing evidence of non-point source pollution, seasonally varying concentrations of pollutants, particularly turbidity, TSS and TP. The highest overall concentrations occur in spring time for most metrics for all stations in the watershed. The arch shaped graphs for TP and TSS are examples of this pattern. Exceptions are the higher median concentrations of TP and TN at Nehring Creek during the summer-fall, the higher kjeldahl nitrogen concentrations at the most downstream station during summer-fall, and the higher *E. coli* concentrations on Illinois Creek during the summer-fall. Spring concentrations of TSS on Lower Mill Creek exceed those previously thought to impair aquatic life as a long-term concentration, and may be cause for some concern regarding the management of lands in the alluvial valley along Mill Creek. While not shown in summary statistics, the highest *E. coli* concentration in the KDHE database occurred at Lower Mill Creek, visible on the far right of the *E. coli*/discharge graph, and high flows can contribute greatly to the absolute loads of pollutants like TP and TSS, as seen in their respective graphs. These very high concentrations tend to occur during the spring, and only at the most downstream station in the watershed.

The Mill Creek watershed is fortunate to have long-term gage records that coincide with the chemical and biological monitoring data. The discharge data indicates that, to the extent that any concern is warranted at all, most pollutants are entering the streams in this watershed during high flow events, and that under ambient conditions water quality is consistently good. One possible exception to that generalization is the very low flow conditions on Nehring Creek, where the beginnings of a U-shapped curve are occurring on *E. coli* and TN graphs. As noted elsewhere, a U-shaped curve tends to indicate that very low flows have somewhat elevated concentrations, which can be a sign of direct loading from point sources or livestock in the stream, with low flows unable to dilute the impact of the source. While point sources, such as municipal discharge are not present in the Nehring Creek watershed, there may be direct inputs of animal waste as livestock congregate in wetted areas during low flow periods. If this is the case, some provision for alternative watering sites and other exclusion activities may ensure that the exceptional water quality observed elsewhere in the Mill Creek watershed is maintained in Nehring Creek. Additionally, the rapidly rising TSS & TP concentrations during high flow events

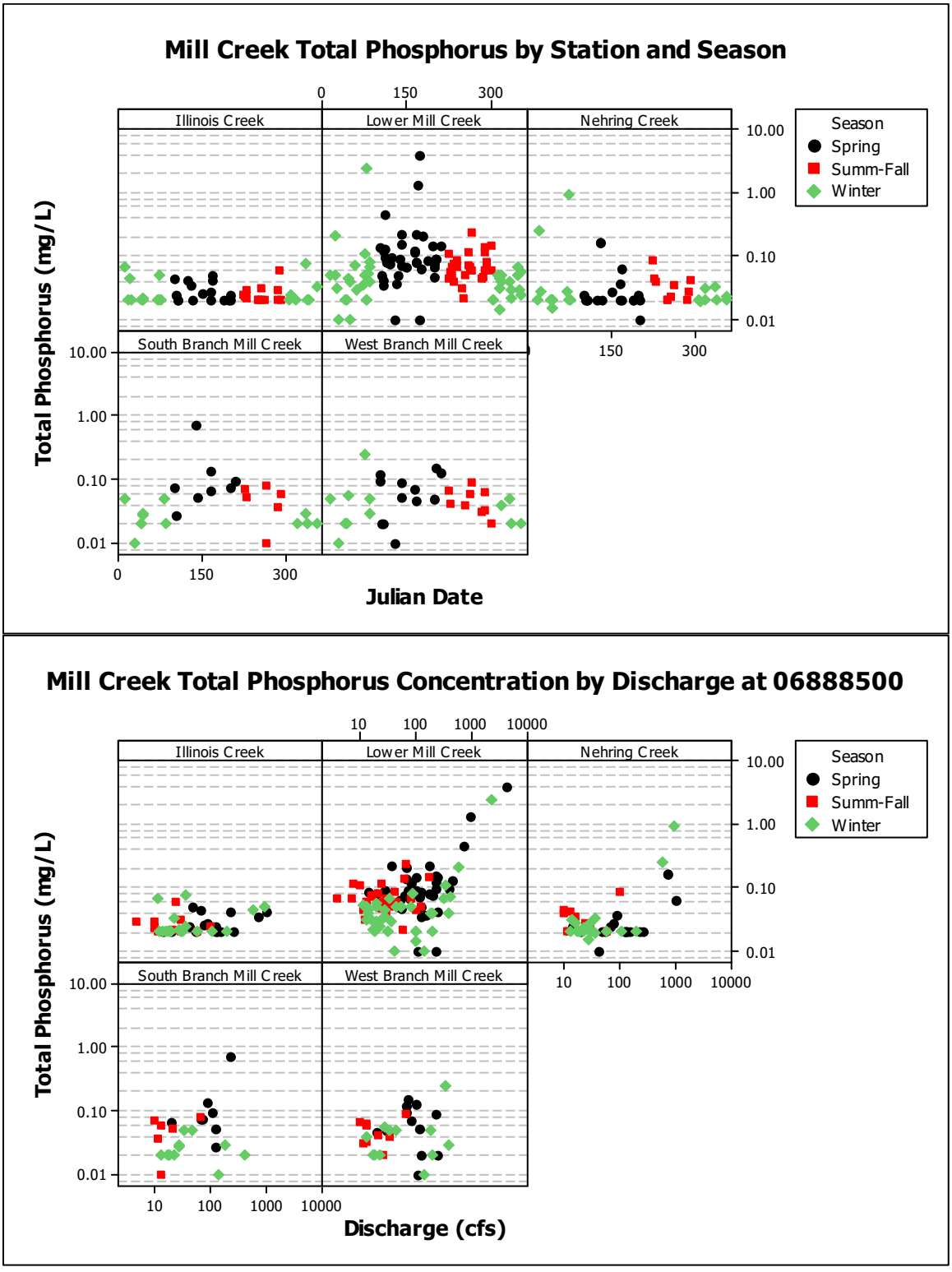
in Nehring Creek are not seen in Illinois Creek, suggesting some localized source that is contributing at high flows. While the total cropland in this area is low, a few small fields may have sections of poor buffering just upstream of the Nehring Creek station (SC727), which could be contributing to this pattern.

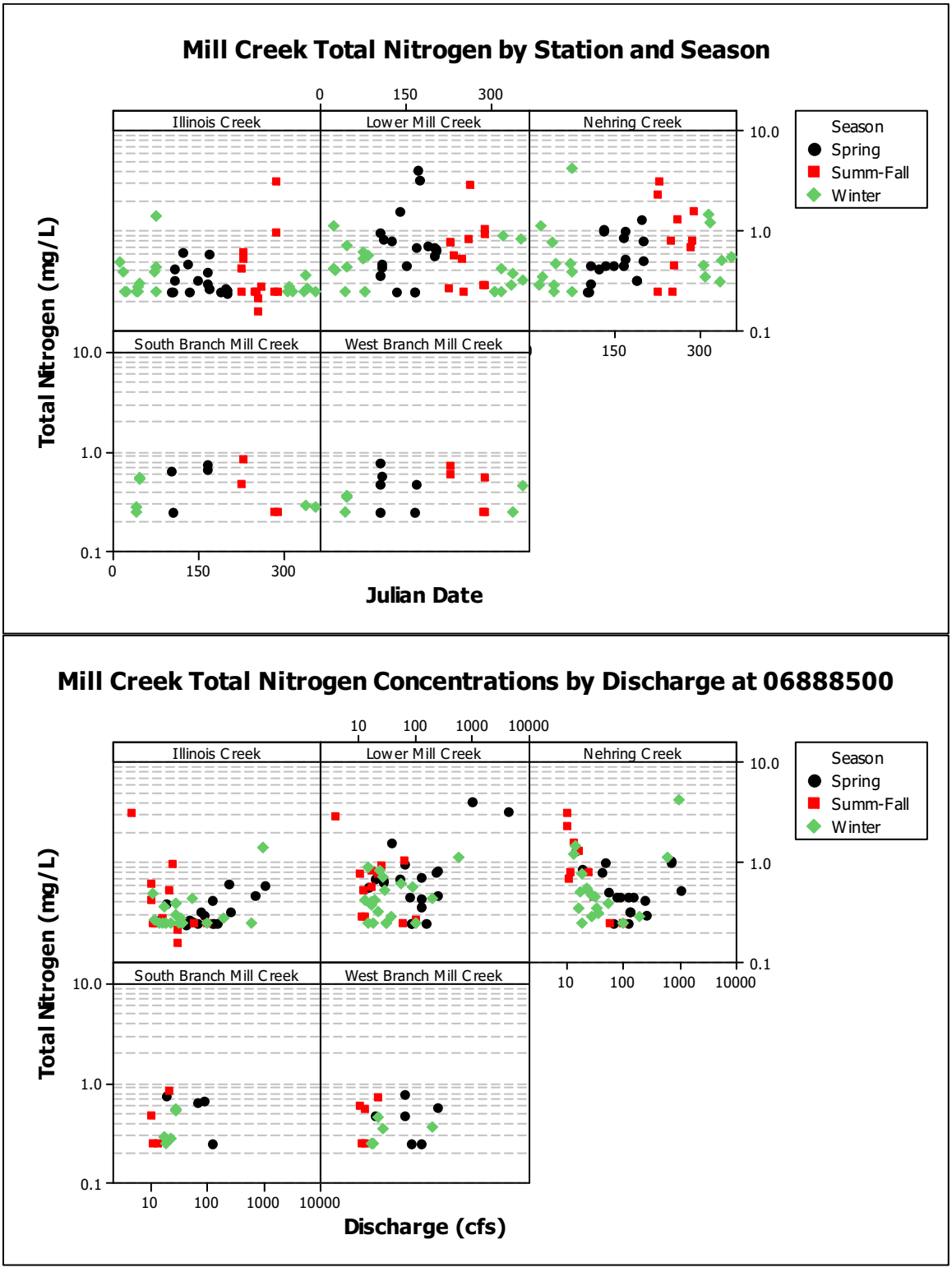
Biological monitoring data indicate an overall picture of relatively good support for aquatic life, with moderately impaired values some of the time. Previous work on the data from this watershed indicates that for as much as 60 days following a major storm even the macroinvertebrate community is impaired, likely due to the washing out of both mature adults and juveniles needed to recolonize the area. Work at Konza Prairie demonstrated that the distance to a source of replacement macroinvertebrates, such as a less-effected downstream water, is an important part of the recolonization rate for macroinvertebrates in prairie streams. While not analyzed here, it is possible that some of the partially-supporting designations at SB521 are correlated with the elevated spring concentrations of TSS, which could impair species dependent on gills for breathing and possibly impair species that reproduce once per year if they reproduce primarily during the spring.

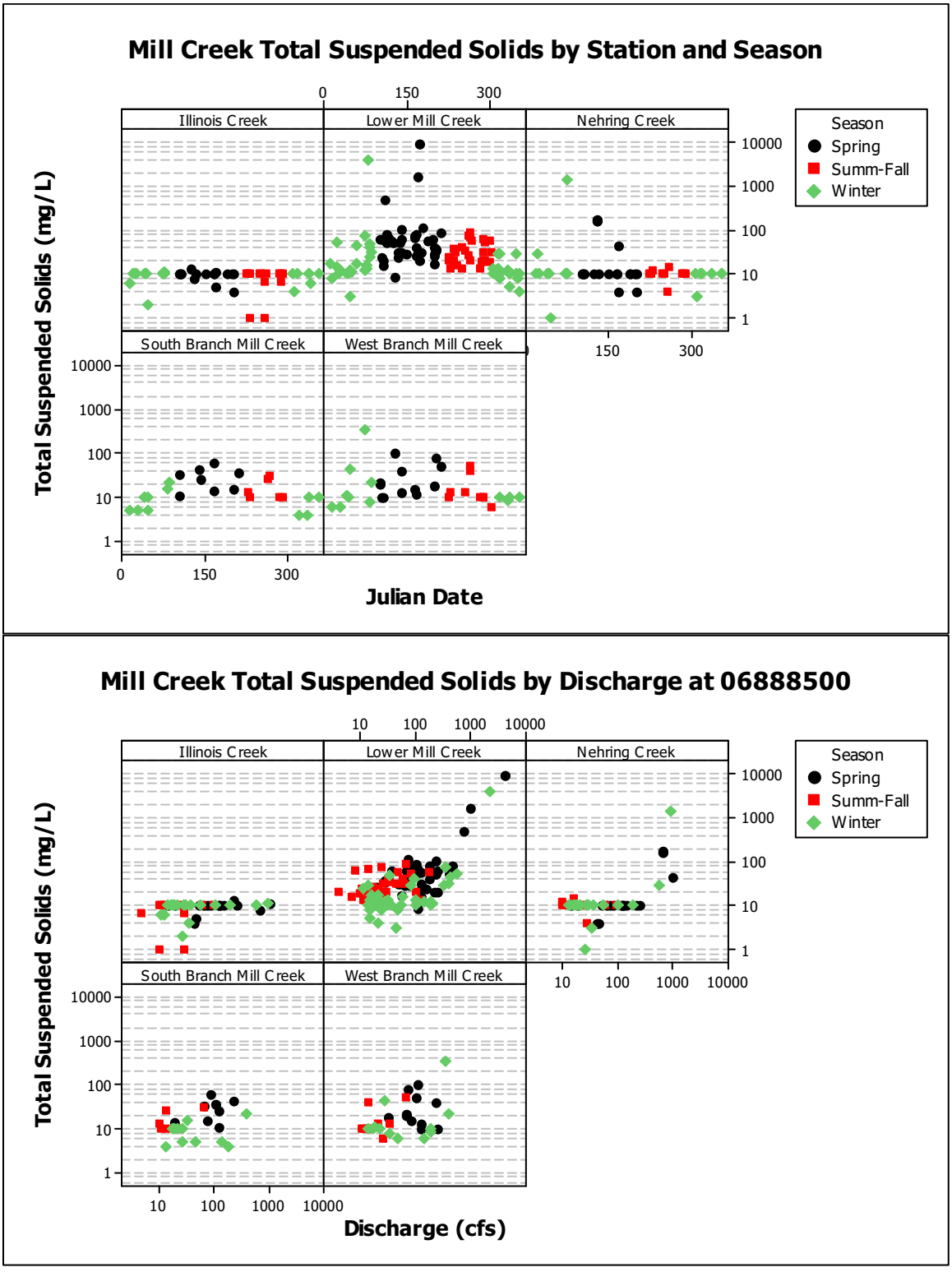
Site	Season	Turbidity Median	TSS Median	TP Median	TN Median	Kjeldahl Median	*E.coli* Median	TOC Median
West Branch Mill SC506	Overall	5.2 (33)	12 (33)	0.05 (33)	0.4085 (16)	0.299 (16)	≤10 (8)	2.4835 (16)
SC506	Spring	7.25 (12)	20 (12)	0.0625 (12)	0.4865 (6)	0.3365 (6)	≤10 (3)	2.667 (6)
SC506	Summer-Fall	3.5 (9)	≤10 (9)	0.043 (9)	0.565 (5)	0.415 (5)	15.5 (2)	2.088 (5)
SC506	Winter	2.49 (12)	≤10 (12)	0.035 (12)	0.352 (5)	0.171 (5)	≤10 (3)	2.388 (5)
South Branch Mill SC519	Overall	4.05 (26)	10.5 (26)	0.0435 (26)	0.3895 (14)	0.1385 (14)	≤10 (7)	2.0935 (14)
SC519	Spring	11.7 (8)	30.5 (8)	0.0765 (8)	0.6665 (4)	0.2415 (4)	58.5 (2)	3.315 (4)
SC519	Summer-Fall	4.03 (6)	11.5 (6)	0.0575 (6)	0.366 (4)	0.161 (4)	20 (2)	2.366 (4)
SC519	Winter	2.2 (12)	≤10 (12)	0.02 (12)	0.2885 (6)	0.1385 (6)	≤10 (3)	1.827 (6)
Lower Mill SC521	Overall	12.1 (107)	26 (107)	0.063 (104)	0.536 (51)	0.291 (51)	31 (29)	3.234 (43)
SC521	Spring	20 (39)	52 (39)	0.09 (39)	0.66 (19)	0.43 (19)	35.5 (10)	3.719 (16)
SC521	Summer-Fall	11.55 (28)	25.5 (28)	0.07 (27)	0.669 (12)	0.539 (12)	41 (7)	3.234 (11)
SC521	Winter	5.3 (40)	12 (40)	0.04 (38)	0.4135 (20)	0.2535 (20)	15 (12)	2.8935 (16)
Illinois SC726	Overall	0.71 (48)	≤10 (48)	0.021 (48)	0.271 (48)	0.104 (48)	31 (28)	1.657 (45)
SC726	Spring	0.77 (16)	≤10 (16)	0.0245 (16)	0.286 (16)	0.1135 (16)	41.5 (10)	2.092 (15)
SC726	Summer-Fall	0.65 (13)	≤10 (13)	0.022 (13)	0.25 (13)	0.1 (13)	86 (7)	1.494 (11)
SC726	Winter	0.7 (19)	≤10 (19)	≤0.02 (19)	0.27 (19)	0.103 (19)	≤10 (11)	1.508 (19)
Nehring SC727	Overall	1.06 (47)	≤10 (47)	≤0.02 (47)	0.479 (47)	0.137 (47)	74 (29)	1.81 (45)
SC727	Spring	1.845 (18)	≤10 (18)	≤0.02 (18)	0.461 (18)	0.1295 (18)	146 (11)	2.26 (17)
SC727	Summer-Fall	1.365 (10)	≤10 (10)	0.031 (10)	0.8135 (10)	0.124 (10)	30 (6)	1.265 (9)
SC727	Winter	0.78 (19)	≤10 (19)	≤0.02 (19)	0.468 (19)	0.137 (19)	47 (12)	1.596 (19)

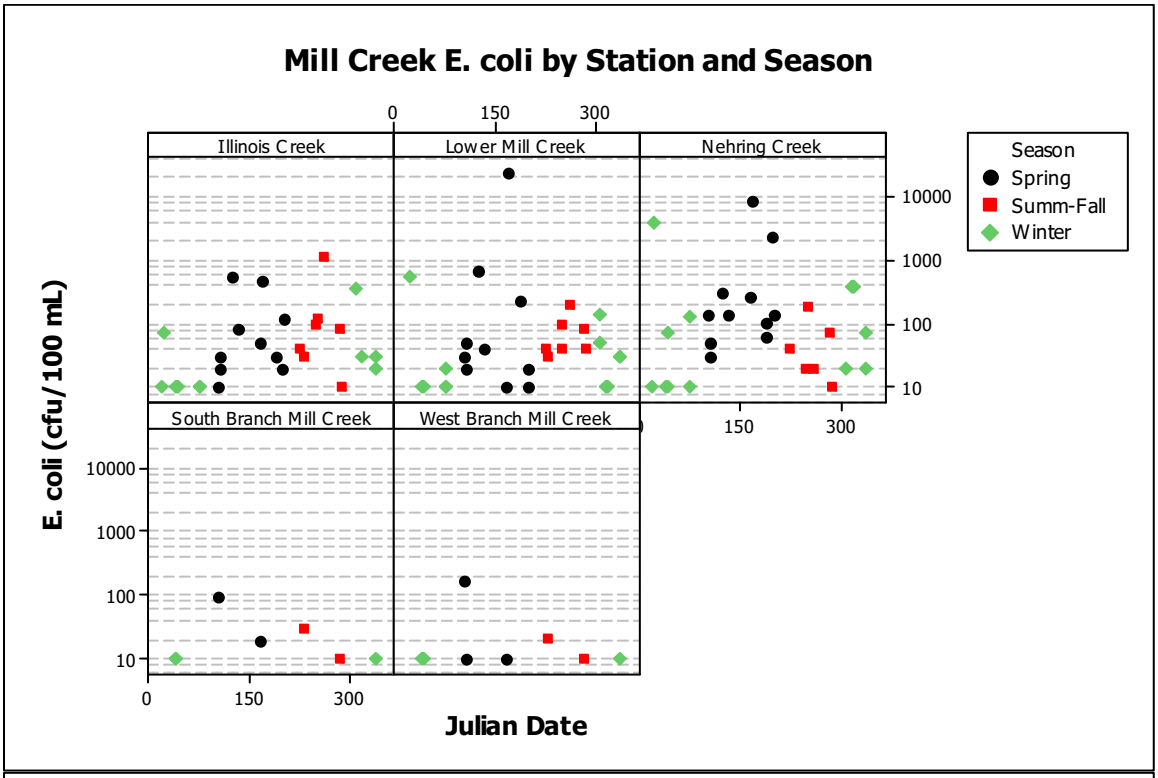
Stream chemistry data for all five KDHE monitoring sites in the Mill Creek Watershed by season and overall. Number in parenthesis is sample size.

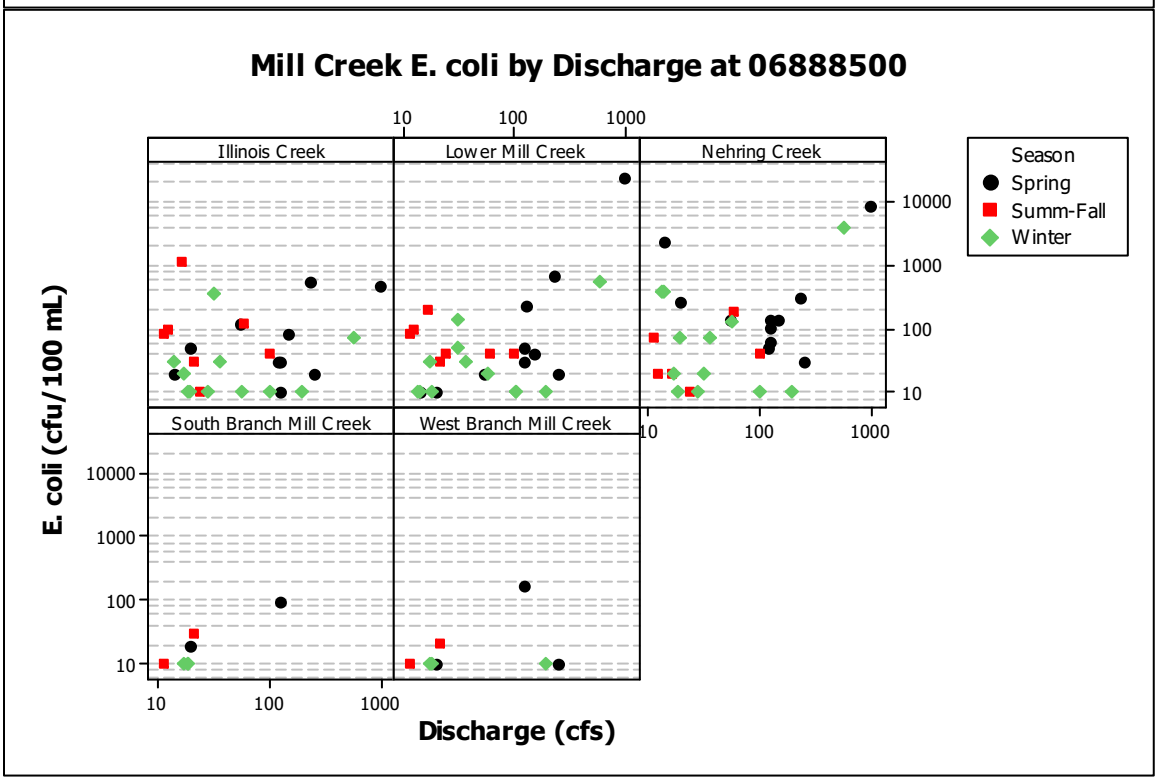
This aerial photograph, from the 2006 NAIP, shows the location of row crop fields somewhat upstream from the KDHE monitoring station. The fields are visible in light brown, and can be seen in some locations directly adjacent to the creek.

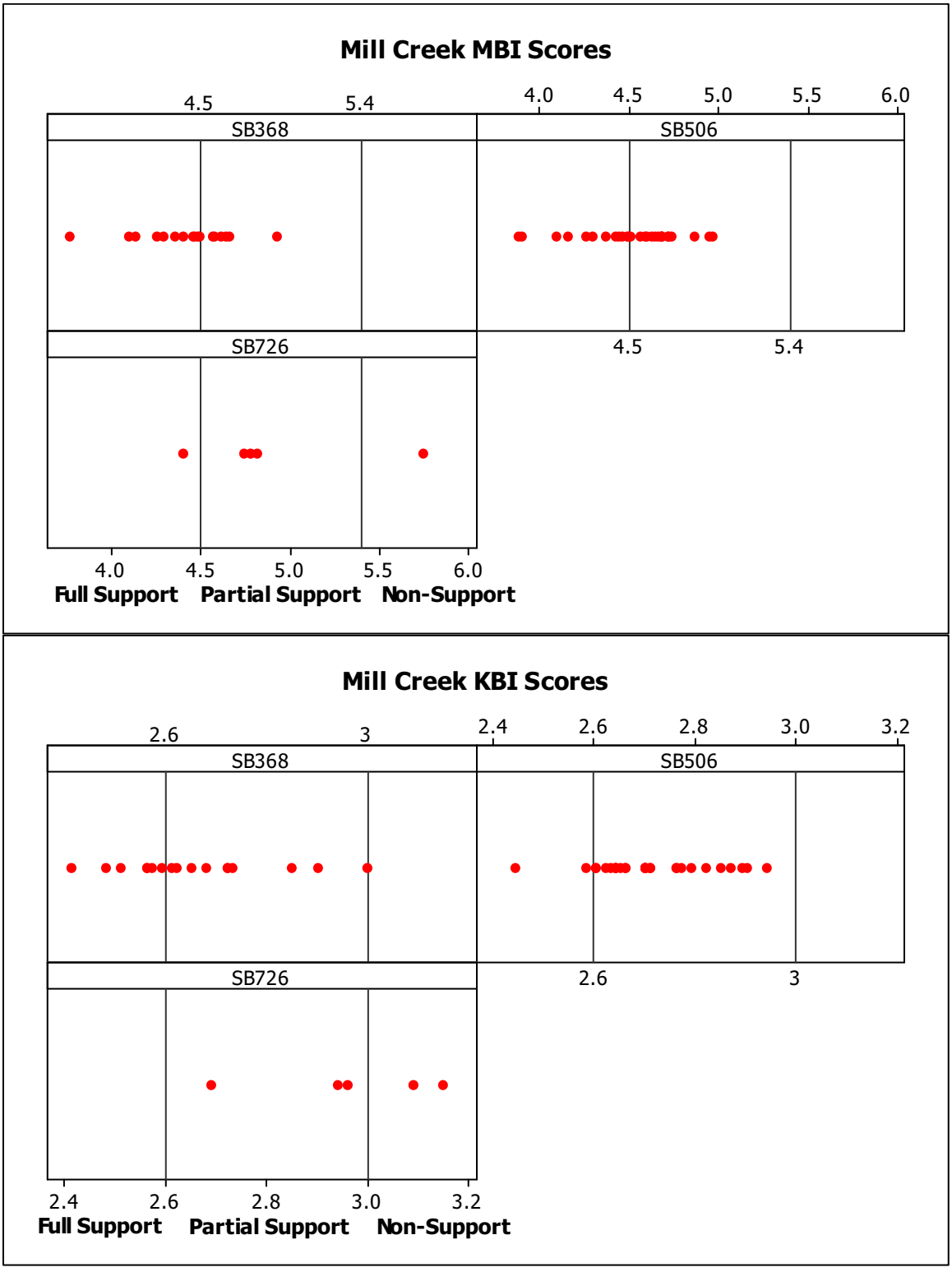

Mill Creek Total Phosphorus by Station and Season
Illinois Creek
Lower Mill Creek
Nehring Creek
South Branch Mill Creek
West Branch Mill Creek
Total Phosphorus (mg/L)
Julian Date
Season
Spring
Summ-Fall
Winter
Mill Creek Total Phosphorus Concentration by Discharge at 06888500
Discharge (cfs)

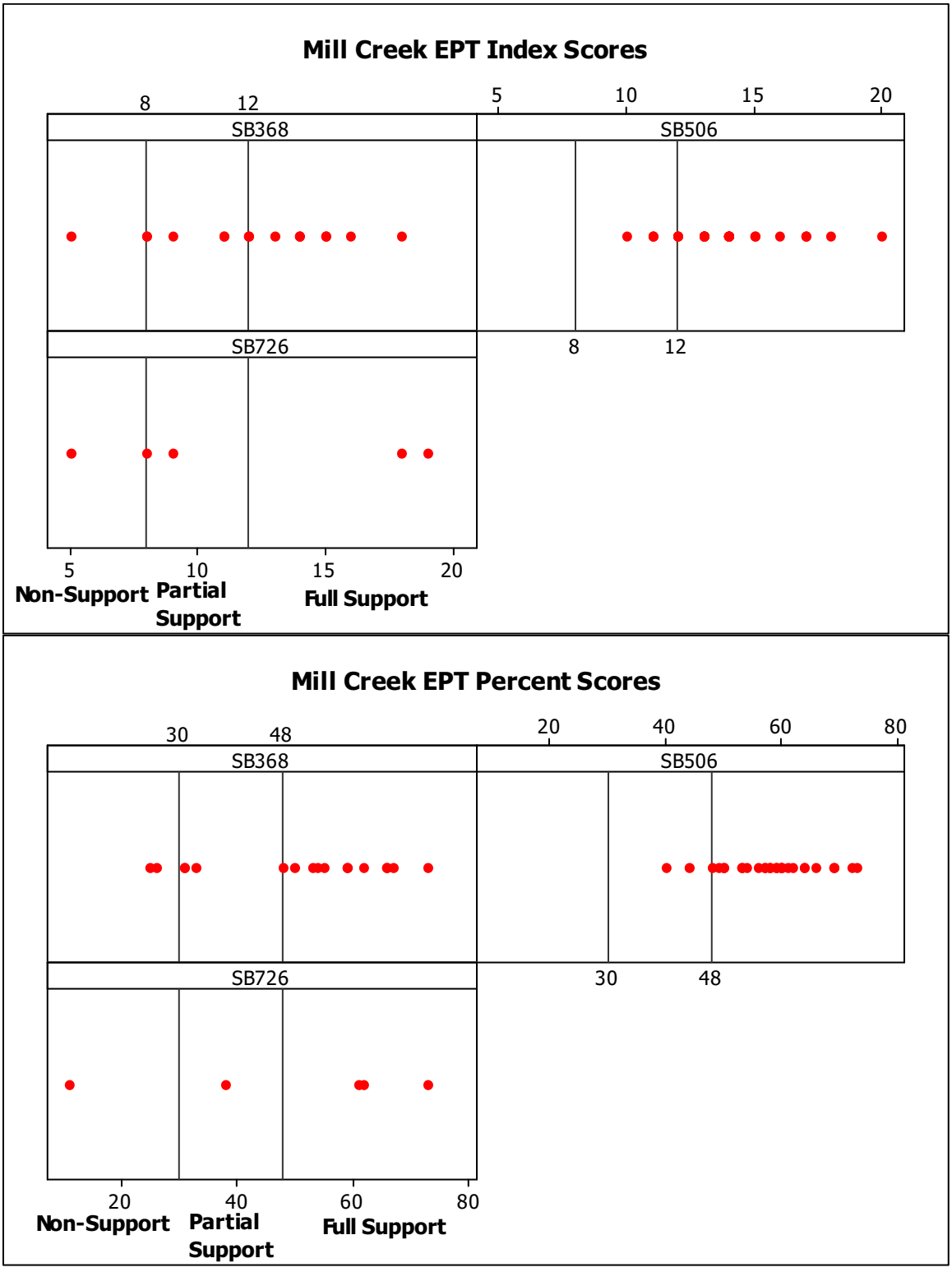

Mill Creek Total Nitrogen by Station and Season
Illinois Creek
Lower Mill Creek
Nehring Creek
South Branch Mill Creek
West Branch Mill Creek
Total Nitrogen (mg/L)
Julian Date
Season
Spring
Summ-Fall
Winter
Mill Creek Total Nitrogen Concentrations by Discharge at 06888500
Discharge (cfs)


Mill Creek Total Suspended Solids by Station and Season
Illinois Creek
Lower Mill Creek
Nehring Creek
South Branch Mill Creek
West Branch Mill Creek
Total Suspended Solids (mg/L)
Julian Date
Season
Spring
Summ-Fall
Winter
Mill Creek Total Suspended Solids by Discharge at 06888500
Discharge (cfs)

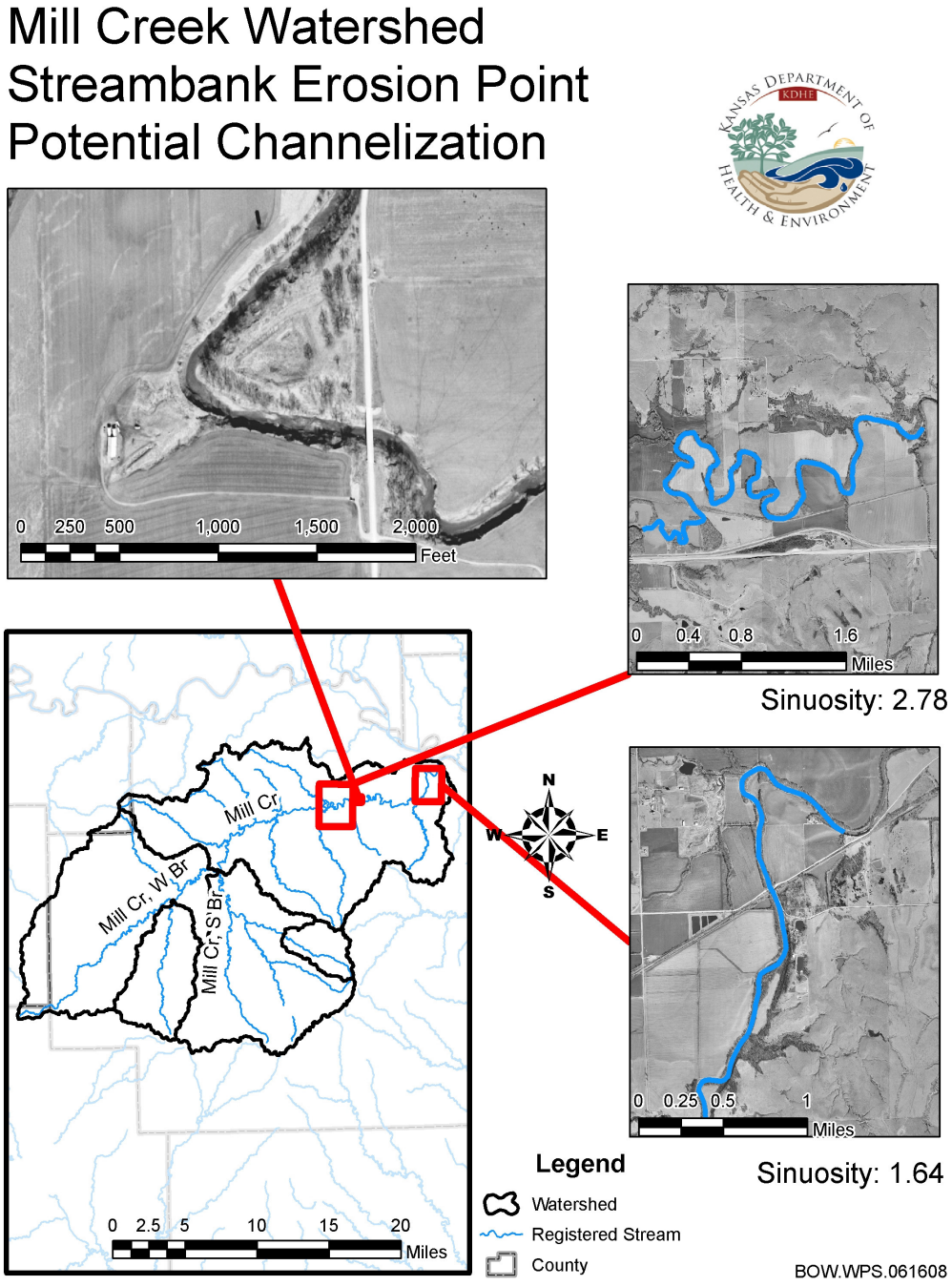

Mill Creek E. coli by Station and Season
Illinois Creek
Lower Mill Creek
Nehring Creek
South Branch Mill Creek
West Branch Mill Creek
E. coli (cfu/100 mL)
Julian Date
Season
Spring
Summ-Fall
Winter


Mill Creek E. coli by Discharge at 06888500
Illinois Creek
Lower Mill Creek
Nehring Creek
South Branch Mill Creek
West Branch Mill Creek
E. coli (cfu/100 mL)
Discharge (cfs)
Season
Spring
Summ-Fall
Winter


Mill Creek MBI Scores
4.5
5.4
4.0
4.5
5.0
5.5
6.0
SB368
SB506
SB726
4.5
5.4
4.0
4.5
5.0
5.5
6.0
Full Support
Partial Support
Non-Support
Mill Creek KBI Scores
2.6
3
2.4
2.6
2.8
3.0
3.2
SB368
SB506
SB726
2.6
3
2.4
2.6
2.8
3.0
3.2
Full Support
Partial Support
Non-Support



Streambank stabilization may play an important role in improving water quality in the lower Mill Creek watershed. One meter resolution aerial photographs were used to identify a number of potential unstable streambanks in the lower reaches of the watershed. Inspection of stream channel sinuosity also suggests that channelization has occurred, and may be contributing to the observed water quality.



Uncertainty-

The availability of gage data concurrent with all the stream chemistry data and biology data reduce some of the uncertainty regarding water quality in this watershed. While the gage is not directly co-located with any of the stream chemistry sites, it is likely to be a good indicator of the relative flow conditions occurring in this watershed at the time of sampling. Because biology data are collected annually or less frequently, there is less certainty regarding the applicability of the data across time. Previous

research on this, and other similar watersheds in Kansas, have noted a strong "harshness" effect of rapidly rising and falling floods, as occur in areas with relatively shallow soils. This harshness can result in temporary reductions in the observed biotic indexes as macroinvertebrates are dislodged during large storm events. Other uncertainty exists due to maximum/minimum reporting limits on chemical parameters monitored by KDHE. For some time TSS concentrations have been measured only down to 10 mg/L, and TP concentrations down only to 0.02 mg/L. In exceptional areas, like the upstream waters of the Mill Creek drainage, data are often recorded at the reporting limit, leaving uncertainty regarding the actual concentrations of these constituents. At this level of analysis we cannot assign sources to particular pollutants, though increasing nutrient and TSS concentrations moving downstream are correlated with increasing row-crop production. It is also not possible at this level of analysis to determine the source of bacteria, leaving uncertainty regarding the relative contributions from cattle and wildlife.

Adaptive Implementation Strategies-

The Mill Creek watershed has among the finest water quality in Kansas. Adaptive implementation in this watershed can be divided into two major areas, protection of existing water quality in the upper reaches and improving water quality in the downstream reaches. In the upper reaches of Mill Creek, as noted in the Nehring Creek data, there may be some localized or seasonal water quality concerns that can be addressed by ensuring appropriate buffering of the areas in row crop production and by working to reduce direct impacts of cattle grazing on the streams and streambanks. These efforts may reduce the limited impacts observed in the upper reaches. The upper reaches also pose an opportunity to provide education and outreach to other grassland watersheds in the WRAPS area, and other parts of the state, to help reduce the impacts of livestock grazing on Kansas Streams. Land managers and owners in the upper reaches of Mill Creek have done an admirable job of protecting water quality and should be recognized for their work to ensure that continued high quality grazing management occurs.

The lower reaches of Mill Creek, generally the area east of Alma, and more specifically the valley along Mill Creek itself could benefit from improved buffering of the creek from row crop production. The rich valley soils provide ideal conditions for raising a variety of row crops, and the continued success of these farms will benefit from preserving available farmland by reducing both overland and streambank erosion. Water quality notably declines, particularly sediment and phosphorus concentrations along this stretch of Mill Creek, and that is likely to be linked to inputs of soil during wet periods of the year. Expansion of, or establishment of, wooded riparian corridors along the entire creek will reduce sediment loading, particularly from stream bank sources. Overland flow may be a smaller component of the conditions experienced along the lower reaches of Mill Creek due to the minimally sloping soils. Efforts to identify eroding streambanks and establish effective riparian buffers are likely to have the largest beneficial effects on water quality in this area.

Some elevated *E. coli* concentrations have been observed in Mill Creek. However, under ambient conditions, *E. coli* concentrations fall below levels of concern for primary contact recreation such as swimming.

Mill Creek and its tributaries are a valuable water quality resource in the Middle Kansas, and of statewide significance with regard to baseline conditions that allow us to better understand what kind of high quality water we can expect in our streams and rivers. Efforts to protect and preserve the water quality in this watershed may be justified as a high priority, given the statewide significance of their ambient conditions when establishing goals for other areas.